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The Forest Insect and Disease Situation, *Lake States, 1960*

LAKE STATES FOREST EXPERIMENT STATION
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FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Foreword

Forest insects and diseases are ever-present threats to Lake States timber resources. Past losses in tree growth and mortality are indicative of how destructive such pests have been and may continue to be in the years ahead. To appraise adequately the regionwide insect and disease situation, the Lake States Forest Experiment Station summarizes each year the information on the current status of insect infestations and disease infections.

To prepare such a report it is essential that use be made of all available information. Many individuals, State organizations, and forest industries have been helpful. Their active and willing cooperation is gratefully acknowledged. Special acknowledgment is made of the information and help given by the following.

U. S. Forest Service:

Office of Forest Pest Control, Division of State and Private Forestry, Regional Office, Milwaukee, Wis.

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Division of Forestry, Conservation Department
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Michigan State University

Minnesota:

Division of Forestry, Conservation Department
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University of Minnesota

Wisconsin:

Forest Management Division, Conservation Department
Office of State Entomologist, Department of Agriculture
University of Wisconsin

Copies of the report may be obtained from the Lake States Station, who collected some of the original material, summarized all information, and processed the report.

Cover picture: Polyporus betulinus fruiting bodies on white birch.

THE FOREST INSECT AND DISEASE SITUATION

LAKE STATES, 1960

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Lake States Forest Experiment Station[1/]
Forest Service, U. S. Department of Agriculture
St. Paul 1, Minnesota

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Introduction

Insects and diseases play an important part in the reduction of our vast forest resource. Each year they cause large losses in timber growth and result in tree mortality. But that is not all: These agents attack the forest from seed to finished product. Stocking levels are lowered, growth is retarded, and trees are deformed, thus reducing both quality and quantity of forest products. The protection of our forests against these destructive agents is the responsibility of everyone concerned with the national economy.

This report summarizes the information collected by many agencies and individuals on the forest insect and disease situation in the Lake States during 1960. The most important aspects are presented briefly in the next few pages. For more detailed discussion see sections on The More Important Forest Insects (or Diseases).

Highlights of 1960

Forest Insects

Populations of the jack-pine budworm increased greatly in several areas in Wisconsin, the Upper Peninsula of Michigan, and Minnesota.

Two species of pine sawflies occurred in outbreak proportions in the three Lake States.

The spruce budworm outbreak in northeastern Minnesota expanded in area and increased in intensity.

The Saratoga spittlebug required chemical treatment of thousands of acres to prevent tree mortality and deformity.

Populations of the forest tent caterpillar declined to the lowest level for the past several years.

Forest Diseases

Winter injury on conifers was particularly severe this year. In Wisconsin some balsam fir were reported to have been killed, primarily the younger aged trees in exposed locations.

A number of hardwood diseases are prevalent in the Flambeau River State Forest in Wisconsin. Leaf yellowing and top dieback are common on many species, with some mortality occurring.

Pine-oak rust has been found on over 90 percent of the jack pine in some Michigan plantations. More than one-half of these infections were on the main stems.

Pine needle rust was very common, especially in red pine plantations, during the year. This disease does not normally cause serious damage to affected trees.

Oak wilt was found on the Nicolet National Forest in Oconto County, Wis., this year. Since this is an area from which the disease had not previously been reported, it represents an increase in the known range of the disease.

The maple blight situation in Wisconsin continues to improve, no new reports of blight having been received. At present some investigators think that defoliation followed by an early frost, while the reflush of foliage was still succulent, may have been responsible for this condition.

A North Dakota shelterbelt survey was made by the Station during the summer of 1960. According to this survey, boxelder blight continues to be the most prevalent tree disease in that area.

Dutch elm disease is now firmly established in Wisconsin and Michigan, but as yet has not been found in Minnesota. In those areas where it is present, control efforts are limited to municipalities where the expense can be justified on the basis of aesthetic values.

The More Important Forest Insect Developments

The status of the more important forest insect pests in the Lake States is listed in the following pages. Species of less importance are included but not discussed in detail.

Spruce Budworm-- Increases in Intensity

The spruce budworm (Choristoneura fumiferana) remains as the most important forest insect pest in Minnesota. The most significant change during 1960 was the expansion in acreage of severely defoliated spruce-fir type along the Canadian border. Up to 4 years of heavy defoliation has caused extensive top killing and tree mortality on approximately 96,000 acres. Plot data from areas of severe defoliation show up to 78 percent top killing and losses as great as 2.4 cords per acre.

In addition to the expanding severe-defoliation category, moderate-to-heavy defoliation was first noted during 1960 on extensive stands of spruce-fir in the vicinity of Brule Lake in Lake County about 20 miles northwest of Grand Marais. This was the only major increase in the gross area of moderate-to-severe defoliation. Although a small population of budworms can be found to the south of the main infestation, defoliation remains light in the large stands of susceptible types.

DDT was applied from the air during June to about 24,000 acres of spruce-fir type in the Superior National Forest. This included several recreational areas sprayed by helicopter to minimize the possibility of spray drift over lakes and streams. Egg counts, subsequent to spraying, indicated an influx of gravid female moths in the periphery of some of the sprayed blocks. However, control on all areas was very good, and none will need to be resprayed in 1961. The State of Minnesota in cooperation with the Minnesota and Ontario Paper Company and the U. S. Forest Service plan to spray about 16,000 acres of spruce-fir type in 1961. The area is approximately 25 miles south of International Falls.

Jack-Pine Budworm--Several Outbreaks

Populations of the jack-pine budworm (Choristoneura pinus) increased greatly in certain areas of all three Lake States. On the Chippewa National Forest in Minnesota, defoliation was moderate to severe on about 15,000 acres. This area was just west of Lake Winnibigoshish. Egg counts and numbers of parasites indicate a population decline in 1961. East of Cass Lake, Minn., about 1,000 acres of jack pine interspersed with red pine was sprayed in late June to suppress budworm populations. A very high degree of control was obtained.

The expected increase of budworm populations was realized in northwestern Wisconsin during 1960. Washburn, Douglas, and Bayfield Counties had the highest populations. Of this general area, approximately 8,300 acres of moderate-to-heavy defoliation occurred on the Washburn District of the Chequamegon National Forest. The remainder of the defoliated jack pine is on State, county, and private lands. Where the timber cannot be harvested, plans are under way to protect certain stands with DDT applied from the air.

In Michigan heavy defoliation was noted and mapped on 2,500 acres of the Ottawa National Forest north of Sidnaw, and on 4,900 acres of the Manistique District of the Upper Michigan National Forest north of Manistique. In addition, moderate-to-heavy defoliation occurred on extensive acreages of jack pine near Raco, Mich., where timely harvest is expected to preclude the need for insecticidal treatments.

European Pine Shoot Moth--Situation More Promising

The European pine shoot moth (Rhyacionia buoliana) was temporarily set back in 1958 and 1959 because of the low winter temperatures. This decline was still felt in 1960. In addition, many of the heavily infested plantations, once considered worthless, have had an opportunity to grow rapidly and are now outgrowing the damage. Even though these plantations have not been sprayed it seems likely that many straight crop trees will result.

The Michigan Department of Conservation clipped and burned infested shoots on 75 acres of red pine on the Fife Lake State Forest in late May and early June. In addition, DDT sprays were applied to 123 acres in late June. The spray program to eliminate shoot moth in Michigan nurseries was successful except for a few beds in one nursery. The

infested beds were fumigated with methyl bromide before the transplants were sent out.

Populations in southeastern Wisconsin were generally light but showed an increase over 1959 in Manitowoc County.

Saratoga Spittlebug--Requires Constant Attention

Although many of the red pine stands in the region are now large enough to be out of danger from attack by the Saratoga spittlebug (Aphrophora saratogensis) this pest remains a threat to thousands of acres of young pine stands and plantations.

In five Wisconsin counties, 1,599 acres of red pine plantations were aerially sprayed by the Wisconsin Conservation Department to control the spittlebug. A mist blower was used on 45 acres in Douglas County. The U. S. Forest Service sprayed 2,814 acres of red pine: Nicolet National Forest, 1,917 acres; Upper Michigan National Forest, 709 acres; and Menominee Indian Reservation, 188 acres--the last in cooperation with the Bureau of Indian Affairs.

The Saratoga spittlebug has a rather low reproductive potential, and the nymphs are extremely sensitive to desiccation. To offset this, however, parasitism and predation are not significant. Nearly every year nymphal populations are sharply reduced in local areas because of hot, dry weather or late spring frosts. Because of this, population checks should be made just prior to control operations. Nymphal counts in 1960 showed a sharp reduction on some areas of the Nicolet National Forest, where very warm weather coupled with no measurable rain for 13 days caused young nymphal mortality.

Adult survey checks reveal that 3,384 acres of national forest lands will require nymphal surveys and possible controls in 1961. The plantations are located on the Nicolet, Chequamegon, Ottawa, Upper Michigan, and Lower Michigan National Forests.

White-Pine Weevil--Damage Increasing

Although the white-pine weevil (Pissodes strobi) has long been a serious pest, its importance in this region seems to be increasing. Michigan reported damage by this insect on several red pine plantations from 1½ to 2½ feet in height. Formerly, damage to red pine has largely been restricted to larger host trees. The Michigan Department of Conservation hand-sprayed 300 acres of jack pine with DDT. The sprayed area was only 0.7-percent weeviled, while unsprayed portions and adjacent plantations were 30-percent weeviled. The heaviest infestations in Michigan occur in the northern portion of the Lower Peninsula, where 60-percent weeviling has been reported in many jack pine and white pine plantations.

Excellent control of this weevil was obtained on small acreages of white pine, Scotch pine, and Norway spruce in northeastern Wisconsin by using lindane and aroclor.

Larch Sawfly--Extends Range

The larch sawfly (Pristiphora erichsonii) has caused moderate-to-complete stripping of many tamarack stands throughout the Lake States region for the past several years. Many stands show little or no net increment, and top killing and whole-tree mortality are occurring. During 1960 the defoliation was quite variable in the three States. Defoliation decreased somewhat in the western section of Michigan's Upper Peninsula, while in Minnesota defoliation extended south into central Pine County. Top killing was evident in many stands in west-central Wisconsin.

Although the infestation remained generally about the same in 1960 as in previous years, extreme local variability in degree of defoliation was common. This could have been caused by abrupt water level changes. No chemical control action has been taken, and none is contemplated at this time.

Red-Headed Pine Sawfly--Slight Decline Starting

The red-headed pine sawfly (Neodiprion lecontei) has been in outbreak in the northern portion of Michigan's Lower Peninsula for several years. Populations remained high in the northwestern portion of the Lower Peninsula, but declines occurred elsewhere in Michigan and this is expected to continue.

The Michigan Department of Conservation aerially sprayed 3,129 acres of red pine and jack pine plantations with 1 pound of DDT in 1 gallon of oil per acre. The total acreage includes the buffer strips around plantations. Excellent control was obtained.

This species of sawfly appears to be increasing in north-central Minnesota. Many roadside trees have been severely defoliated. Control was applied with ground equipment to populations of sawflies on jack pine in Aitkin and Itasca Counties.

A heavy infestation was detected on 40 acres of red pine underplanting on the Hayward District of the Chequamegon National Forest. Hand spraying was used to check the insect. The Wisconsin Conservation Department used hand-operated equipment to treat 25 acres in Marinette County. About 88 acres were aerially treated in conjunction with Saratoga spittlebug spraying on the Rapid River District of the Upper Michigan National Forest.

Introduced Pine Sawfly--Sharp Increases Locally

The introduced pine sawfly (Diprion similis) caused heavy defoliation of white pine and jack pine on several areas in Wisconsin and Minnesota. In Crow Wing County, Minn., both jack and white pines were severely defoliated. In this area first-generation adults appeared about the last week in June. Second-generation adults appeared about the first week in August. A total of 112 cocoons were collected; 65 of these were parasitized by Monodontomerus dentipes, 2 by Dahlbominus fuscipennis, and 1 by Amblymerus verditer for a total of 61-percent parasitism. In addition, 34 were dead from unknown causes.

High populations of this sawfly were found in the Wausau-Merrill area in Wisconsin. Random collections of cocoons revealed that 47 percent were parasitized and 3 percent dead from unknown causes. High populations are expected in this general area again in 1961.

Populations in the second generation of this sawfly species were much more numerous than in the first. Apparently overwintering losses are high.

Pine Root Collar Weevil--Widespread on Sandy Soils

The pine root collar weevil (Hylobius radicis) was reported from numerous new areas as survey intensity increased. Tree mortality caused by this insect has increased in Michigan. In a 23-year-old red pine and jack pine plantation in Kalkaska County about 20 percent of the attacked trees were dead. In addition, many of the remaining trees are infested and are expected to die. This insect is probably present on most of the sandy soils in the coniferous areas of the Lake States.

A related species (Hylobius pales) is also destructive to young pine seedlings following logging operations. Recently a root-feeding weevil in the genus Hylobius was found severely damaging jack pine in central Wisconsin. The taxonomy of this genus remains somewhat confused, and positive identification of species cannot always be obtained.

White Grubs--Sprays Often Needed

An increasing acreage of new planting is being treated for control of white grubs in the genus Phyllophaga. Many of the planting sites in the Lake States region are old sod fields. These areas are ideal for high populations of grubs. If unchecked, the voracious grubs frequently girdle or sever the roots of newly planted trees. Even if the tree does not die, it may be severely stunted. An attachment has been designed to fit on planting machines so that aldrin can be applied to the root system as the trees are planted. This has greatly reduced losses. When hand planting is used, the planting stock can be dipped in the aldrin solution. If the area to be planted is covered with grasses and hardwood trees are nearby, the soil should be carefully examined for grubs prior to planting.

A Pine Tip Moth--May be Widespread

A pine tip moth (Rhyacionia adana), first reported in Michigan in 1959, was reported from additional locations in 1960. In Michigan this pest has been found in most red pine plantations from 1 to 2 feet tall. It has also been found on jack pine. An insect causing similar damage was collected from the Willow River State Nursery in Minnesota and tentatively identified as this species. Adults were not obtained and positive identification cannot be made without them. Damage resembling the typical injury caused by this terminal feeder has been noted in Wisconsin. Since the eggs are laid in April, this insect may easily be distributed on infested nursery stock.

Zimmerman Pine Moth--Damage More Apparent

The Zimmerman pine moth (Dioryctria zimmermani) and its close relative D. cambiicola have caused extensive damage to red pine of all ages on portions of the Cutfoot-Sioux Experimental Forest near Cass Lake, Minn. Larvae were frequently found in galls of the pine-oak rust Cronartium cerebrum. The Zimmerman pine moth was also found in nearly every jack pine stand examined in Michigan. The biology and ecology of these two insects are not well understood, but they are apparently much more common than was previously realized. Their habits of killing new shoots and mining the cambial region could threaten Christmas tree production in local areas.

Black Pine Leaf Scale--First Reported Damage

The black pine leaf scale (Aspidiotus californicus), normally not considered a serious pest in this region, caused extensive damage on about 2,000 acres of jack pine in Polk County, Wis. Some tree mortality is likely in at least two 20-year-old plantations. The scales attach to the needles and are quite inconspicuous (fig. 1).

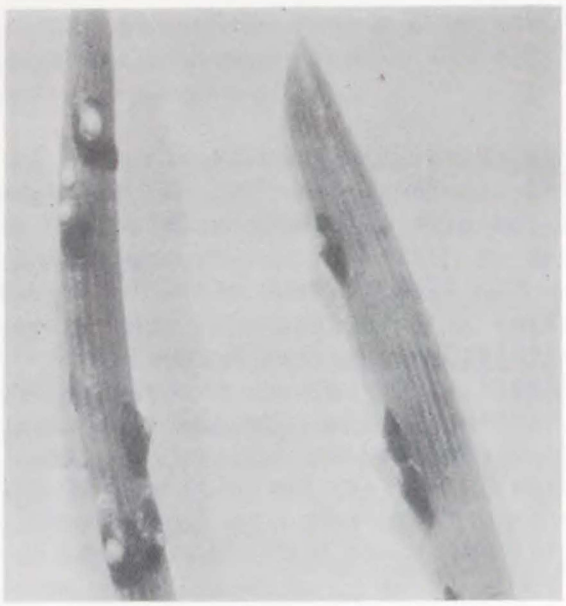

Figure 1.--The black pine leaf scale (Aspidiotus californicus on jack pine needles. (Courtesy of the Wisconsin Conservation Department.)

Gypsy Moth-- No Moths Trapped

The Michigan Department of Agriculture reported the status of the gypsy moth (Porthetria dispar) in Michigan as follows. "Approximately 1,152,000 acres were trapped this summer utilizing 5,000 traps placed approximately 2 per square mile. For the second year no moths were trapped and, of course, a spray program will not be necessary for the spring of 1961. Our previous negative year was in 1958, and if 1961 proves to show negative results, we, of course, will be able to discontinue this program in the anticipation that this particular pest has been eradicated."

Shelterbelt Survey-- Shows Many Insects

Surveys in the shelterbelt areas disclosed the presence of many insects, three of which are briefly described.

The woolly elm aphid (Eriosoma americanum) was particularly plentiful on American elm in eastern North and South Dakota. Very heavy infestations were reported, particularly in urban plantings. Of the approximately 160 elm plantings examined in shelterbelts, 42 percent were infested.

The boxelder twig borer (Proteoteras willingana) was found on about 23 percent of the trees examined. Stunting and browning were evident on the shelterbelt trees.

Lacebugs were rather common on bur oak. Many adults, nymphs, and eggs were present, and stippling and yellowing of the foliage were observed from mid-June to October.

Other Insects--Potentially Destructive

The following insects are potentially destructive but are not presently causing serious tree damage over large acreages in the Lake States.

1. The forest tent caterpillar (Malacosoma disstria). Populations are the lowest they have been in the Lake States in many years.

2. The pitch nodule maker (Petrova albicapitana). The outbreak previously reported in Michigan's Upper Peninsula remains, but generally endemic populations exist elsewhere.

3. The pine tortoise scale (Toumeyella numismaticum). Occasional local infestations are reported, but no widespread outbreak has been detected.

4. The yellow-headed spruce sawfly (Pikonema alaskensis). Windbreaks, roadsides, and ornamental spruces were defoliated in north-central Minnesota counties (fig. 2).

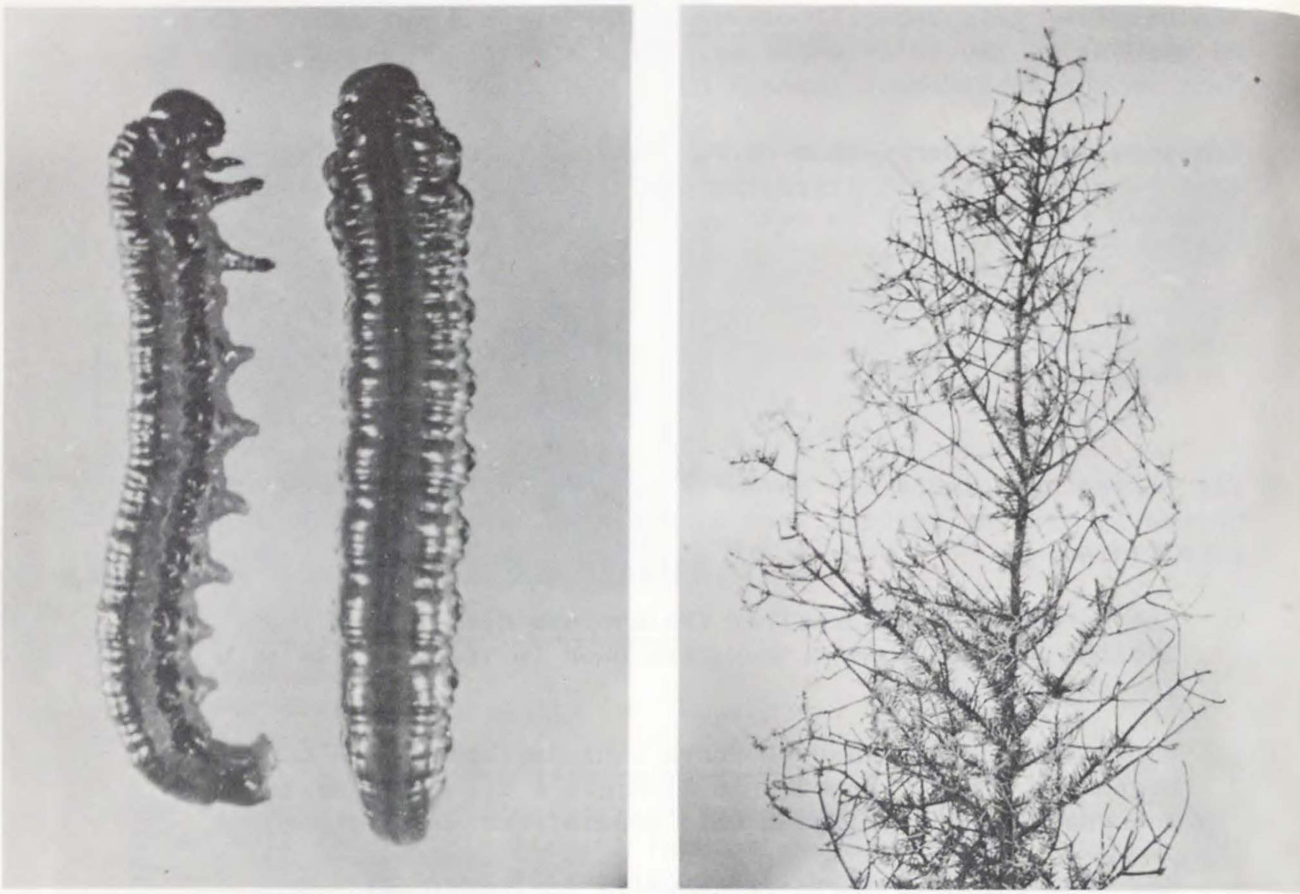

Figure 2.--Larvae of the yellow-headed spruce sawfly and a white spruce partially defoliated by this insect.

The More Important Forest Disease Developments

Some of the important tree diseases in the Lake States are discussed briefly in the following pages. The discussion is limited to new diseases and those for which new and significant information was obtained.

Extensive Winter Injury on Conifers

Winter injury was unusually prevalent throughout the Lake States during the year. While some winter injury normally occurs, the conditions which cause this disturbance were particularly severe during the winter of 1959-60. Although the brown needles associated with winter injury are very conspicuous, ordinarily this condition does not cause serious damage to the tree. In Wisconsin, however, it was reported that some balsam fir were killed last year as a result of severe winter injury. This was particularly noted on young trees in exposed areas.

Hardwood Diseases Prevalent in Flambeau River State Forest

Leaf yellowing and top dieback have developed on a number of the hardwoods in the Flambeau River State Forest in Wisconsin. This yellowing and dieback are often followed by death of the tree. The most commonly affected trees are black ash, elm, sugar maple, hemlock, and yellow birch, with hemlock being the hardest hit. On maple the symptoms begin with the development of brightly colored foliage on a single branch, often a side branch. Young trees have premature bright red and yellow discoloration, and death begins at the top and progresses downward. These symptoms resemble a condition of maple previously observed in southern Wisconsin. It has not been possible to devote much effort to an investigation of this problem up to this time.

Pine-Oak Rust Serious in Michigan Plantations

Pine-oak rust, common throughout the region, causes considerable damage, especially in nurseries and plantations. This damage results from direct killing of the tree or predisposing the stem to windthrow (fig. 3).

Examination of jack pine plantations in Otsego County, Mich., disclosed that in many places over 90 percent of the trees were infected with pine-oak rust.[1/] More than 50 percent of these infections were located on the main stem. The abundance of this and other rusts on jack pine is causing considerable concern among foresters and forest landowners.

Figure 3.--Portion of a jack pine stem with several galls caused by pine-oak rust. Multiple infection by this rust is very common.

1/ Reported by Paul R. Flink of the Michigan Department of Conservation.

Pine Needle Rust Common in Red Pine Plantations

Pine needle rust was prevalent throughout the area during the year, especially in red pine plantations. Normally this disease is not serious enough to cause any appreciable damage, although in some instances the bulk of any one year's foliage may be affected (fig. 4). Because of the wide distribution of alternate hosts, no attempt is made to control this disease.

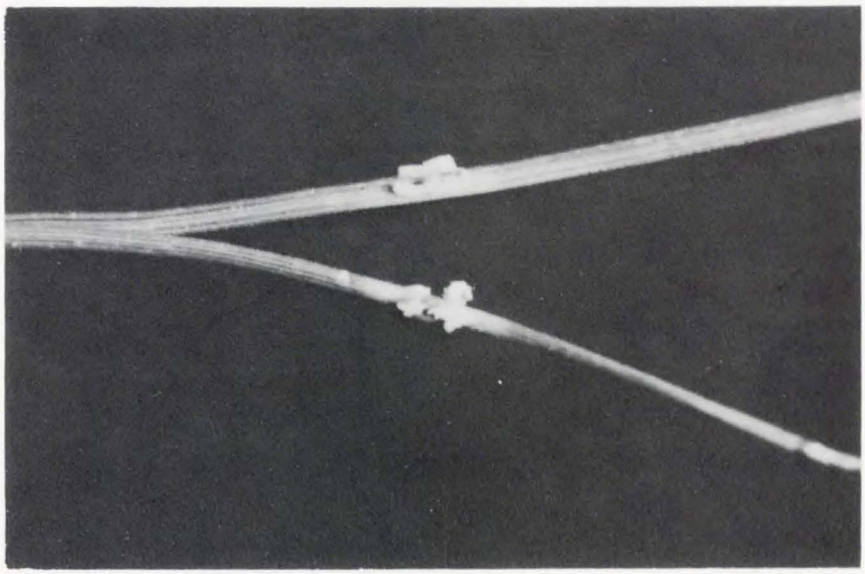

Figure 4.--Red pine needles infected with pine needle rust.

Range of Oak Wilt Extended in Wisconsin

Oak wilt was found on the Lakewood District of the Nicolet National Forest this year. Since the disease had not previously been reported in this area, the discovery extends the known range of the disease as indicated in figure 5. This represents the first increase in the known range in several years. As yet no attempt has been made to determine the extent of this new infection.

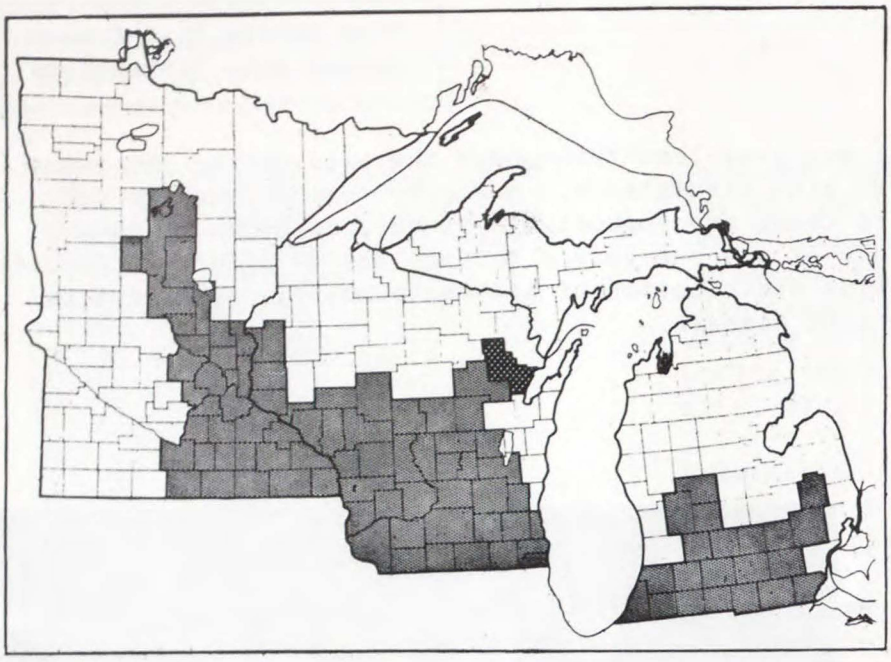

Figure 5.--Known range of oak wilt in the Lake States represented by shaded area. Cross-hatching in Oconto Co., Wis., shows increase in range.

Maple Blight Situation Still Improving

Maple blight is a term used to describe a condition in north-central Wisconsin where sugar maple trees of all sizes began dying over an area of about one township in the summer of 1957. In addition to the original area, locations with similar conditions were later found but each of these was only 1 to 2 acres in size. These smaller areas were reported in 1958, but the condition appeared to have arisen the previous year. Since that time no new areas of blight have been reported.

Considerable mortality occurred in the blight area during the first 2 years, and an extensive logging operation was carried out to salvage affected trees, both living and dead. Since 1959, however, remaining trees that were less seriously affected have shown marked improvement until at present little evidence of maple blight remains in the area.

Several investigators are attempting to determine the cause of maple blight. These workers have approached the problem in various ways. At present the consensus is that this condition resulted from defoliation of the trees by insects, followed by an early frost which occurred while the new foliage was still succulent.

Shelterbelt Survey Discloses Numerous Diseases

An insect and disease survey of North Dakota shelterbelts was conducted during the year by Louis Wilson of the Station's Forest Insect Division. A summary of his disease findings is presented in table 1.

Table 1.--Prevalence of diseases in North Dakota shelterbelts as observed in 1960

Disease and hosts	No. of sampled trees		Percent of total diseased
	Total	No. diseased	
Boxelder blight			
Boxelder	181	130	72
Siberian elm	138	33	24
American elm	165	25	15
Green ash	206	8	4
Chokecherry	42	1	2
Wild grape	4	4	100
Shot hole			
Chokecherry	42	18	43
Black knot (Dibotryon)			
Chokecherry	42	4	10
Sand cherry	6	1	17
Cedar apple rust			
Juniper	45	2	4
Dieback			
Russian olive	107	10	9
Leaf spot			
Green ash	206	17	8
Plum	88	2	2
Tar spot			
Silver maple	4	1	25
Hypoxylon			
Aspen	6	1	17
Damping off			
Ponderosa pine (In nursery beds)	1	1	100

The most prevalent tree disease in North Dakota continues to be boxelder blight, which is commonly noted on many trees and shrubs. This condition, characterized by dwarfing and curling of the leaves, is particularly noticeable on boxelder; hence the name. Research at the Station's Bottineau, N. Dak., field office has shown fairly conclusively that boxelder is extremely sensitive to 2,4-D and that the blight was caused by spray drifting in from weed control operations during the early part of the growing season. Work on this problem has included placing insect exclosures around nursery-grown trees to determine if there is any connection between the blight and the presence of insects. Because of vandalism, it has not been possible to obtain a satisfactory test of this possible relationship.

Dutch Elm Disease Still Not Present In Minnesota

Dutch elm disease, which is now firmly established in both Michigan and Wisconsin, has not as yet been found in Minnesota. There is, however, no reason to assume that it will not enter the State in the future. Efforts to control this disease in Michigan and Wisconsin are limited to municipalities where the costs can be justified on the basis of aesthetic values.

Storms Damage Some Stands

Frequently agents such as strong winds, ice storms, and hail showers cause severe damage locally. In many cases, this may not be noticed until later, when the cause of damage may be obscured. Hail severely damaged all species of trees on about 400 acres in Dickinson County, Mich. Red pine, jack pine, and aspen up to 8 inches in diameter were killed. A stand of jack pine on the Washburn District of the Chequamegon National Forest was also severely injured by hail. The symptoms of hail damage are lesions and bruises on the twigs. Also, one side of the tree is often damaged more severely than the other.

SOME RECENT STATION PAPERS
Lake States Forest Experiment Station

Wood Use by Manufacturing Firms in Minneapolis and Saint Paul, by John R. Warner and Carl H. Tubbs. Sta. Paper 75, 30 pp., illus. 1959.

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Influence of Ownership on Forestry in Small Woodlands, by Charles F. Sutherland, Jr., and Carl H. Tubbs. Sta. Paper 77, 21 pp., illus. 1959.

Volume Tables for Aerial Timber Estimating in Northern Minnesota, by Gene Avery and Merle P. Meyer. Sta. Paper 78, 21 pp., illus. 1959.

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Michigan's Forest Resources, by Virgil E. Findell, Ray E. Pfeifer, Arthur G. Horn, and Carl H. Tubbs. Sta. Paper 82, 46 pp., illus. 1960.

European Pine Shoot Moth Damage as Related to Red Pine Growth, by H. J. Heikkenen and W. E. Miller. Sta. Paper 83, 12 pp., illus. 1960.

Streambank Stabilization in Michigan--A Survey, by W. D. Striffler. Sta. Paper 84, 14 pp., illus. 1960.

Pulpwood Production in Lake States Counties, 1959, by Arthur G. Horn. Sta. Paper 85, 13 pp., illus. 1960.

Evaluating the Growth Potential of Aspen Lands in Northern Minnesota, by R. O. Strothmann. Sta. Paper 86, 20 pp., illus. 1960.

The Climatic Distribution of Blister Rust on White Pine in Wisconsin, by E. P. Van Arsdel, A. J. Riker, T. F. Kouba, V. E. Suomi, and R. A. Bryson. Sta. Paper 87, 34 pp., illus. 1960.